

Calypso console was used to shift the patient to the exact isocenter position. The following imaging protocol was followed; Day 1-3 CBCT, or until 3 consecutive CBCTs showed acceptable bladder fullness and an empty rectum, afterwards only 1 CBCT per week. Following a CBCT we would manually match the transponders and apply any necessary shifts. The discrepancy between the CBCT and the Calypso shifts was then noted. We also recorded maximum prostate motion shown on the Calypso tracking station during the treatment, as well as the time that the beam was held due to prostate motion outside of set tolerances.

**Results:** The average discrepancy between the Calypso transponder match and CBCT in the lateral direction was  $-0.09 \pm 0.46$  mm, longitudinal  $0.81 \pm 0.66$  mm, and vertical  $-0.69 \pm 0.68$  mm. The average prostate motion during irradiation was  $0.44 \pm 0.82$  mm in the lateral direction,  $0.3 \pm 1.4$  mm in the longitudinal, and  $0.4 \pm 2.0$  mm in the vertical direction. The maximum prostate motion recorded was 0.64 cm in the vertical direction, and was the result of the patient coughing during treatment. In this case the beam was held for 120 seconds, and the patient had to be shifted back to the isocenter. On one other occasion, the beam was held for 5 seconds before the prostate moved back within tolerance.

**Conclusions:** Based on the positioning accuracy that we have seen from the Calypso system, we will soon begin to treat prostate patients using the SBRT technique. So far, prostate motion has been seen to be quite stable during treatment, with the largest prostate motion occurring in the vertical direction. Our preparations will help us in setting prostate SBRT motion tolerances. We will continue to use Calypso for positioning and tracking prostate motion.

#### PO-1111

Comparison of Exactrac Imaging and CBCT for brain SRS, focusing on efficacy, accuracy and economic factors

S. Nicholls<sup>1</sup>, K. Clarke<sup>1</sup>, G. Fogarty<sup>1</sup>

<sup>1</sup>Genesis Cancer Care, Mater Radiation Oncology, Sydney, Australia

**Purpose/Objective:** SRS is becoming a standard treatment in many departments. However conventional external beam treatments such as VMAT are able to deliver similar treatments especially for oligometastatic disease to the brain. We performed a prospective trial on 10 patients being treated for melanoma brain metastases comparing BrainLab's Exactrac Imaging and CBCT, focusing on efficacy, accuracy and economic factors.

**Materials and Methods:** 10 cases of SRS planned for single fraction treatment on a Varian Unique Linear Accelerator using the BrainLab Exactrac Imaging System and 6D robotic couch were replanned for VMAT treatment on a Varian 21IX Linear Accelerator using CBCT imaging on a standard couch. Planning and treatment time, imaging accuracy and economic factors were assessed.

**Results:** Planning time for SRS using BrainLab's iPlan for treatment on the Varian Unique machine could take anywhere from 3 hours to several days depending on the number of metastases, while VMAT planning took less on average, around 4 hours regardless of the number of metastases. Treatment time using Exactrac Imaging ranged from 20 to 45 minutes, with longer treatment times needed for patients with multiple metastases. With VMAT, treatment

times were more consistent with almost all cases taking 30 minutes to treat regardless of the number of metastases. Although treatment time was much quicker, the time to acquire the CBCT was longer compared to Exactrac Imaging. Accuracy of less than 0.5 mm in six planes was achieved on BrainLab's robotic couch which was much better than the 1 mm tolerance on a standard couch for VMAT.

**Conclusions:** Comparing iPlan to VMAT, planning times are similar unless multiple metastases are being planned in which case VMAT is much quicker. Treatment and imaging times are similar, however VMAT treatment times were more consistent regardless of the number of metastases being treated, this in particular is clinically important for work flow of the department. The imaging tolerances of CBCT are less accurate than Exactrac Imaging and this should be taken into account when considering the use of CBCT for SRS brain treatments. In our cases corrections could only be accounted for x, y and z planes rather than 6 planes which BrainLab's robotic couch offers. The accuracy of Exactrac Imaging, while beneficial, may not necessarily be needed for SRS treatments of oligometastatic disease to the brain. The use of CBCT for imaging is still an efficient and economical substitute for radiation therapy centres who do not have access to Exactrac Imaging. However it is important that doses are assessed with regard to imaging tolerances.

#### PO-1112

Quantification of interfractional movement of the oesophagus and the influence on the dose to the oesophagus

E.H. Thøgersen<sup>1</sup>, D.S. Møller<sup>1</sup>, L. Hoffman<sup>1</sup>

<sup>1</sup>Aarhus University Hospital, Medical Physics, Aarhus, Denmark

**Purpose/Objective:** Overall survival for lung cancer patients is poor partly due to local recurrence. The local control rate may be improved by increasing the dose. However, if the anatomy of the patient changes during RT these high doses can shift into the oesophagus and other mediastinal organs increasing the risk of severe toxicity.

The aim of this study is to identify how much the oesophagus moves during the RT course and the impact on the dose distribution.

**Materials and Methods:** Twenty consecutive lung cancer patients treated with chemo-RT were included in this study. All patients had a 4D planning-CT scan (p-CT) and two additional 4DCT control scans (c-CT) at fraction 10 and 20. The patients were treated with a homogeneous dose distribution to the target. The maximum dose to the oesophagus was equal to the prescribed dose allowing for a higher dose to maximum 1 cm<sup>3</sup> of the oesophagus. For each patient, an experienced radiographer contoured the oesophagus in two different structures based on the recommendations of the Danish Lung Cancer Group. First, the full extent of the oesophagus (oes) was contoured, and then the oesophagus was contoured in the extent of the tumour (oes-T). In the Eclipse registration module, a rigid 6D tumour match between the p-CT and each of the c-CT scans was performed and the shift of the oesophagus was obtained for the segments oes and oes-T. The treatment plan was copied to the c-CTs using the 6D registration and the dose was re-

calculated by using fixed monitor units and the mean and the maximum dose to the oesophagus were read out.

**Results:** The mean shift of the oesophagus was  $7.5 \text{ mm} \pm 5.3 \text{ mm}$  with a maximum shift of 23.3 mm. In seven patients shifts above 10 mm was observed in one or both control scans. The mean shift in the region of the tumour was  $3.8 \text{ mm} \pm 3.0 \text{ mm}$  with a maximum shift of 13.5 mm. Two patients showed shifts of the oesophagus above 10 mm and in both patients an atelectasis disappeared during the treatment course, whereby the anatomy of the patient changed. The mean dose to the oesophagus at the region of the tumour (eso-T) increased by  $0.4\% \pm 4.4\%$  when the plan was evaluated at the control scans. In three patients, an increase in mean dose above 5% was observed. These patients have anatomically changes such as pneumonia and atelectasis. The maximum dose increased by  $1.3\% \pm 2.6\%$ , with a maximum increase of 10% in one patient. In this patient only minor anatomical changes are observed.

**Conclusions:** The oesophagus moves during the RT course. In three patients, the mean dose to the oesophagus in the tumour region increases with more than 5 % which can correlate with shifts above 10 mm of the oesophagus in two of the patients. Patients with anatomical changes like disappearance of an atelectasis are more likely to receive an increased dose to the oesophagus during the RT course. In the case of dose escalation, these patients may benefit from an adaptive treatment plan during treatment to avoid severe oesophageal toxicity.

#### PO-1113

A Set-up comparison between MV imaging and optical surface monitoring for breast cancer patients

A. Tini<sup>1</sup>, S. Lang<sup>1</sup>, I. Pytko<sup>1</sup>, C. Winter<sup>1</sup>, M. Guckenberger<sup>1</sup>, C. Linsenmeier<sup>1</sup>

<sup>1</sup>University Hospital Zürich, Department of Radiation Oncology, Zurich, Switzerland

**Purpose/Objective:** To compare the accuracy of our conventional set-up technique using MV imaging to an optical surface monitoring set up (OSMS®, Varian) for the treatment of breast cancer patients. Additionally, we evaluated possible changes in breast shape during the course of treatment.

**Materials and Methods:** 7 breast cancer patients were treated using 3D tangential fields. Patients were positioned supine on the breast board according to the external isocenter marks. MV imaging and bone match on the chest wall was done to adjust the position. To track the patients' shifts during the matching procedure, OSMS was used. The OSMS system consists of 6 cameras, which acquire the patients' position in 2D, and a computer vision algorithm, which reconstructs the image in 3D. The patients' reference surface was imported from the CT scan and the region of interest of the treated area was selected. Before and after applying the table shifts based on the 2D MV match, the treatment surface was captured in order to monitor the OSMS corrections in all the translational and rotational directions. The OSMS deltas were compared before performing the couch and MV imaging shifts. Additionally, the difference between the OSMS deltas were calculated, before and after the couch shifts, and then compared to the MV imaging shifts.

**Results:** Mean shift difference between MV and OSMS in the vertical axis was:  $2.3 \text{ mm} \pm 2.1 \text{ mm}$ , in the longitudinal axis

$1.9 \text{ mm} \pm 2.9 \text{ mm}$ , in the lateral axis  $0.9 \text{ mm} \pm 4.2 \text{ mm}$ . The maximum differences were as follows: vertical 8.0mm, longitudinal 8.4mm, and lateral 13.2mm. OSMS showed rotation up to  $3.5^\circ$ , roll to  $4.6^\circ$ , and pitch  $3.1^\circ$ . 6 out of 7 patients showed differences less than 1cm between the imaging techniques, which were attributed to changes based on swelling and arm position. One patient showed a mean lateral discrepancy of 9.3mm during the 13 fractions, which was most likely due to a variation in roll and rotation at the initial CT. The mean absolute difference between the shift registered by OSMS after performing the couch movement and the shift from MV imaging was:  $0.93 \text{ mm} \pm 0.78 \text{ mm}$  in the vertical direction,  $0.94 \text{ mm} \pm 0.75 \text{ mm}$  in the longitudinal, and  $0.7 \text{ mm} \pm 1.0 \text{ mm}$  in the lateral.

**Conclusions:** The OSMS system is helpful in detecting differences between treatment and initial setup during CT simulation such as arm position or patient rotation. Additionally, changes to the breast, such as swelling, can be detected. This is especially important if intensity modulated techniques are applied. Therefore, using OSMS as an additional device to monitor interfractional motion provides useful information leading to more precise positioning of the patients. This may eventually result in being able to apply tighter margins.

#### PO-1114

A multidisciplinary developed optimized imaging strategy for frameless stereotactic radiosurgery

M. McGarry<sup>1</sup>, T. El Kaissi<sup>1</sup>, J. Hayes<sup>1</sup>, M. Riyas<sup>1</sup>, K. Benson<sup>1</sup>, S. Paloor<sup>1</sup>, J. McLellan<sup>1</sup>, S. Sheim<sup>1</sup>, G. Perkins<sup>1</sup>, R. Hammoud<sup>1</sup>, P. Petric<sup>1</sup>, N. Al-Hammadi<sup>1</sup>

<sup>1</sup>Hamad Medical Corporation Al Amal Oncology Centre, Radiation Oncology, Doha, Qatar

**Purpose/Objective:** To determine the optimum online imaging strategy for frameless SRS using ExacTrac based on system accuracy, clinically observed discrepancies between imaging methods and intrafraction motion of the patient in the frameless mask.

**Materials and Methods:** The ExacTrac (ET) system was calibrated using the Winston Lutz test to match the ET imaging and treatment isocenters to within sub-millimeter accuracy as part of acceptance and commissioning. This provided a benchmark for our imaging system. A task based approach was adopted to develop an optimised imaging strategy and associated work instructions. A pilot protocol was implemented for six patients, in which both online cone beam CT (CBCT) and ET based x-ray verification was performed for 24 fractions, with six degrees of freedom within the Brainlab system. From analysis of this data, the imaging strategy was amended and ET only based verification was then carried out for a further 14 patients. In addition, intrafraction motion was determined for 89 fractions quantifying the stability of the masking system and the frequency of verification imaging required.

**Results:** The benchmarking QA process determined typical deviations of  $-0.5 \text{ mm}$  between the radiation and imaging isocentres. Agreement between CBCT and ET verification was less than 0.6mm and 0.5degrees which improved our confidence with the procedure (Fig.1).